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PROBLEMS OF OCCUPATIONAL HEALTH WITH REGARD TO POLYCHLOROCAMPHENE MANUFACTURING PLANTS

[Nekotoryye voprosy gigiyena truda i sostayaniya zdorov'ya rabochikh proizvodstva polikhlorkamfena]

by

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Together with other organochlorine insecticides, compounds of the chlorinated terpene group (polychlorpinene, polychlorocamphene, chloroprene, etc.) have been used in agriculture. The raw material for their production are the products of the distillation of turpentine, produced from conifer pitch.

The present work is devoted to study of the occupational health conditions of polychlorocamphene (PCC) production. It is one of the

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[1]A. Ya. Tubina and A. B. Pshenitsin participated in the work.

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little studied products of this group. PCC production is a batch process, and it consists of several stages: chlorination of camphene to PCC, purging of the latter from the acid gases, production of concentrated PCC and bottling it. Monitoring and regulation of the production process are carried out directly in the equipment, with the exception of the camphene chlorination phase, in which the control and measuring instruments are removed to the control and measuring instrument room. The design of production installations basically satisfies hygienic requirements.

The air of the work places is polluted with camphene polychloro derivatives of camphene, chlorine, hydrogen chloride, spindle oil and hydrocyanic acid. Determination of camphene and PCC in the air was carried out by the methods developed by A. Ya. Tubina and A. A. Belyakov (1966). A total of 1600 samples was analyzed, 588 of them for PCC, 253 for camphene, 444 for chlorine and 312 for hydrogen chloride. Of the compounds listed, the polychloro derivatives of camphene had the most unfavorable effect on the health of the workers. Their concentrations in the camphene chlorination department, as a rule, exceeded the permissible maximum by 2-5 times, by up to 5 times in the PCC concentrate production stage, and 6-10 times in the final product bottling section. The concentrations of the remaining compounds usually were below or at the level of the maximum permissible concentration and exceeded it negligibly, only in individual samples.

The basic causes of pollution of the air of the industrial premises were: insufficient tightness of the equipment and piping used, manual operations in production of the catalyst, pollution of the influent air,

the absence of local exhaust outlets at the sampling valves in the camphene chlorination department, etc. The meteorological conditions in the shop did not always satisfy hygienic requirements, because of the high temperatures of the surfaces of the solutions, inadequate heat insulation of the reactors, and the absence of regulation of steam supply to the heating system at various outside temperatures in the wintertime. Balanced mechanical exchange and local exhaust ventilation had low effectiveness, because of the distance of the local exhausts from the sources of emission of harmful compounds and an inadequate exhaust rate.

The health of 53 PCC plant workers, aged 26 to 45 years, was examined. There were 30 men and 23 women. The basic group of those examined consisted of instrument control men (22 persons), then fitters and mechanics (11), laboratory workers (6) and shift foremen (4). The length of service of those examined in this shop varied from 5 to 15 years (38).

Most frequent were complaints of headache, increased fatiguability at the end of the shift, pains in the region of the heart and sleep disorders (19 persons). As a result of study of the nervous system, various functional disorders were found in 15 persons. They were of a vegetative dysfunction nature in 11 and an astheno-vegetative syndrome in 4. In physical and electrocardiographic studies of the cardiovascular system, sinus bradycardia, sinus tachycardia, respiratory arhythmia, auricular changes, moderate repolarization disorders, a tendency towards hypotonia and asymmetry of the arterial pressure were found in 17 persons. These changes were noted most often against a background of vegetative dysfunction, and they were basically due to extracardiac effects. In

physical and X-ray examinations of the lungs and gastrointestinal tract, no widespread and unidirectional changes were found.

Together with the general clinical examination, the morphological composition and some physicochemical properties of the peripheral blood were studied. The results were compared with the corresponding blood indices of healthy people, according to the data of V. V. Sokolov and colleagues. The data obtained indicate an appreciable shift of the curves, in the direction of a decrease in the hemoglobin and erythrocyte indices of the men ($P<0.001$) and the hemoglobin of the women ($P<0.05$).

The color index was changed little. The reticulocyte content proved to be elevated (12-17‰) in 9 cases. Single erythrocytes with Heinz bodies were found in 13 persons (7 men and 6 women). Determination of the osmotic resistance of the erythrocytes to hypotonic sodium chloride solutions disclosed a decrease in the minimum resistance to 0.52 and maximum to 0.44 in 12 persons. A decrease of only the maximum or only the minimum resistance was noted in 7.

In consideration of the possibility of methemoglobinemia upon exposure to organochlorine compounds, we examined the methemoglobin content of 47 persons, by the method of L. E. Gorn. The methemoglobin content varied within 0.17 and 5.7% in 24 of those examined, and it exceeded the upper normal limit (5%) in 3. An accelerated ESR (15-35 mm per hour) was noted in 15 persons.

In 16 workers, reduced hemoglobin and erythrocyte indices were combined with moderate reticulocytosis, reduced osmotic resistance of the erythrocytes, an increased ESR, and the presence of methemoglobin and erythrocytes with Heinz bodies in the blood. This gave a basis for

a diagnosis of moderate normochromic anemia, with signs of regeneration and decrease in osmotic resistance of the erythrocytes. This blood pattern can evidently be explained by some increase in hemolysis, due to methemoglobinemia and a reduction in the life cycle of the erythrocytes with Heinz bodies. No deviations were found in the leukocyte, as well as blood platelet content.

For the purpose of finding out the role of the occupational factor in the origin of the pathology found, we arbitrarily divided all those examined into 2 groups: the first consisted of 33 workers (instrument control men, fitters attached to the shop, laboratory workers), in whom the degree of contact with the plant hazards was considerable and constant, and the second, of 20 persons (compressor operators, fitters on duty, secondary area janitors, raw material drivers, administrative workers), for whom this contact was relatively small and random. A comparison of the incidence of the diseases found showed that diseases of the teeth, chronic hepatitis, gastritis and subatrophic condition of the upper respiratory passages were distributed approximately the same in both groups, while functional disorders of the nervous system occurred almost 4 times, and normochromic anemia 3 times more often in the first than in the second group. A high degree of deviation of the blood indices was established in the first group. More significant changes were found in the methemoglobin ($P<0.001$) and hemoglobin content of the women ($P<0.05$).

Erythrocytes with Heinz bodies were found only in persons of the first group. The results of comparison of both groups give a basis for considering that, together with other causes, the occupational factor can be of definite importance in the origin of individual changes. The

unfavorable effect of the occupational factor was manifested mainly in functional disorders of the nervous system and in changes of the red blood. According to data in the literature, similar shifts are characteristic of chronic exposure to chlorinated terpenes. This coincides with the results of sanitary and hygienic examination of the plant, and it gives a basis for considering that PCC has the most unfavorable effect.

Improvement in working conditions in the PCC manufacturing plant can be achieved, by means of sealing the equipment, improvement in a number of technological operations (elimination of manual operations, equipment with local exhaust vencilation at the sources of emission of harmful compounds into the air -- packing glands, pumps, sampling valves, camphene melting tanks, in the PCC concentrate bottling section, etc. -- and the conduct of camphene chlorination without overheating the chlorinator surfaces). Pollution of the influent air with product must be eliminated.

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